CLAIMS

1. A deposition method comprising:

at a first temperature, contacting a substrate with a first precursor and chemisorbing a first layer at least one monolayer thick over the substrate; and

at a second temperature different from the first temperature, contacting the first layer with a second precursor and chemisorbing a second layer at least one monolayer thick on the first layer.

2. The deposition method of claim 1 further comprising heating the first layer and the second layer to a third temperature higher than the second temperature.

3. The deposition method of claim 1 further comprising reacting the second layer with the first layer.

4. The deposition method of claim 1 further comprising altering temperature by adding or removing heat with a thermoelectric heat pump to establish the second temperature.

5. The deposition method of claim 4 wherein the thermoelectric heat pump thermally connects to the substrate.

6. The deposition method of claim 1 wherein the second temperature is established before the contacting the first layer by initiating a flow of the second precursor.

7. The deposition method of claim 1 wherein the second temperature is not established until during the contacting the first layer by providing a flow of the second precursor.

8. The deposition method of claim 1 wherein the first temperature is greater than the second temperature.

9. The deposition method of claim 1 wherein the first temperature is at least about 5 °C different than the second temperature.

10. The deposition method of claim 1 wherein the first temperature is at least about 50 °C different than the second temperature.

11. The deposition method of claim 1 wherein the first and second temperatures are those of at least a portion of the substrate.

12. The deposition method of claim 1 wherein the first and second temperatures are those of an outermost surface of the substrate.

13. The deposition method of claim 1 wherein the first and second temperatures are those of the precursors.

14. The deposition method of claim 1 further comprising providing background heat.

15. The deposition method of claim 14 wherein the background heat is provided at a fourth temperature between the first and second temperature.

16. The deposition method of claim 14 wherein the background heat originates primarily from a heat source comprising a heat lamp array or a wafer chuck heater.

17. The deposition method of claim 1 wherein the substrate comprises a bulk semiconductor wafer.

18. The deposition method of claim 1 wherein the first precursor is different from the second precursor.

19. The deposition method of claim 1 wherein the first and second layers each consist essentially of a monolayer.

20. The deposition method of claim 1 wherein at least one of the first precursor and the second precursor comprise a plurality of different precursor species.

21. The deposition method of claim 1 wherein the first and second precursors each consists essentially of a single precursor specie.

22. The deposition method of claim 21 wherein the single precursor specie exhibits only one chemical structure.

23. The deposition method of claim 1 further comprising purging the first precursor before contacting the first layer with the second precursor.

24. A deposition method comprising:

atomic layer depositing a first specie over a substrate approximately at an optimum temperature for the first specie deposition; and

atomic layer depositing a second specie on the first specie approximately at an optimum temperature for the second specie deposition different from the first specie optimum temperature.

25. The deposition method of claim 24 further comprising purging the first specie before depositing the second specie on the first specie.

26. The deposition method of claim 24 further comprising reacting the second specie with the first specie at an optimum temperature for the reaction different from the second specie optimum temperature.

27. The deposition method of claim 24 wherein a chemisorption product of the first and second species consists essentially of a monolayer of a deposition material.

28. The deposition method of claim 24 wherein the first specie is different from the second specie.

29. The deposition method of claim 24 further comprising atomic layer depositing at least one additional specie along with at least one of deposition of the first specie and deposition of the second specie.

30. The deposition method of claim 24 wherein changing from the first specie optimum temperature to the second specie optimum temperature comprises adding or removing heat with a thermoelectric heat pump.

31. The deposition method of claim 30 wherein the thermoelectric heat pump thermally connects to the substrate.

32. The deposition method of claim 24 wherein the first and second specie optimum temperatures are those of at least a portion of the substrate.

33. The deposition method of claim 24 further comprising purging the first specie before depositing the second specie on the first specie.

34. A deposition method comprising:

chemisorbing a first monolayer of a first compound over a substrate while maintaining the substrate at a first temperature with a heater;

adding or removing heat with a device different from the heater and establishing the substrate at a second temperature at least about 1°C different from the first temperature;

chemisorbing a monolayer of a second compound on the first monolayer of the first compound at the second substrate temperature;

adding or removing heat to establish the substrate at approximately the first temperature; and

chemisorbing a second monolayer of the first compound on the monolayer of the second compound.

35. The deposition method of claim 34 wherein the device exhibits a thermoelectric effect.

36. The deposition method of claim 35 wherein adding or removing heat to establish the substrate at approximately the first temperature comprises adding or removing heat with the device.

37. The deposition method of claim 34 wherein the device provides a flow of coolant gas.

38. The deposition method of claim 37 wherein the coolant gas consists of material inert to reaction with the first compound.

39. The deposition method of claim 34 wherein the second temperature is established before the chemisorbing the monolayer of the second compound.

40. The deposition method of claim 34 wherein the second temperature is not established until during the chemisorbing the monolayer of the second compound.

41. The deposition method of claim 34 wherein the first temperature is greater than the second temperature.

42. The deposition method of claim 34 further comprising purging any first compound not chemisorbed before chemisorbing the second compound.

43. The deposition method of claim 34 wherein at least one of the first compound and the second compound is formed from a plurality of different precursor species.

44. A deposition method comprising:

chemisorbing a first monolayer of a first compound over a substrate while maintaining the substrate at a first temperature with a heater;

removing heat by reducing the amount of heat input from the heater and providing a flow of a coolant gas, the removing heat establishing the substrate at a second temperature at least about 1°C lower than the first temperature;

chemisorbing a monolayer of a second compound on the first monolayer of the first compound at the second substrate temperature;

adding heat to establish the substrate at approximately the first temperature; and

chemisorbing a second monolayer of the first compound on the monolayer of the second compound.

45. A deposition method comprising:

chemisorbing a first monolayer of a first compound over a substrate while maintaining the substrate at a first temperature with a heater;

adding or removing heat with a device different from the heater and establishing the substrate at a second temperature at least about 1°C different from the first temperature;

chemisorbing a monolayer of a second compound on the first monolayer of the first compound at the second substrate temperature;

adding heat to establish the substrate at a third temperature higher than the second temperature and reacting the chemisorbed second compound with the chemisorbed first compound;

adding or removing heat to establish the substrate at approximately the first temperature; and

chemisorbing a second monolayer of the first compound on the reacted layer of first and second compounds.

46. The deposition method of claim 45 wherein the device exhibits a thermoelectric effect.

47. The deposition method of claim 46 wherein adding or removing heat to establish the substrate at approximately the first temperature comprises adding or removing heat with the device.

48. The deposition method of claim 45 wherein the device provides a flow of coolant gas.

49. The deposition method of claim 45 wherein the third temperature is established after completing the chemisorbing the monolayer of the second compound.

50. The deposition method of claim 45 wherein the third temperature is established during the chemisorbing the monolayer of the second compound.

51. The deposition method of claim 45 wherein the first temperature is greater than the second temperature.

52. The deposition method of claim 45 further comprising purging any first compound not chemisorbed before chemisorbing the second compound.

53. The deposition method of claim 45 wherein at least one of the first compound and the second compound is formed from a plurality of different precursor species.